SCIENCE REVIEW REPORT
- RESULTS OF ANALYSIS AND DISCUSSION -

REPORT TO THE AD HOC WORKING GROUP
OF THE CAPE BRETON PUBLIC REVIEW

NOVEMBER 29TH, 2002

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1.0 BACKGROUND

In October 2000, the Canada – Nova Scotia Offshore Petroleum Board (CNSOPB) received a joint directive from the federal and provincial governments to conduct a public review of the effects of potential oil and gas exploration and drilling activities within Exploration Licences 2364, 2365 and 2368.

Following this directive, an independent Public Review was conducted, and a final report entitled "*Commissioner's Report on the Effects of Potential Oil and Gas Exploration Offshore Cape Breton*" was submitted to the Board and to the governments in March 2002. The report included a summary of the views of the general public and interested parties, and findings on the effects of potential oil and gas activities within the licence areas. Several recommendations were made in the report, including:

- *that the necessary scientific, technical and experiential resources be convened to assess the existing base of knowledge in relation to the DFO review, the Hunt and Corridor proposals, and the Public Review Commission's Findings; and*

- *that the Ministers and the CNSOPB broaden the consultative system to apply to the next stage of the decision-making process for the three Licence Areas, to include a cross-section of interests for the purpose of gaining advice about whether or not the proposed activities should proceed, and the specific measures to be taken in the event their decision is to proceed with exploration and drilling activities.*

CNSOPB responded to the Public Review by publishing a "*Statement Regarding the Commissioner's Report on the Effects of Potential Oil and Gas Exploration Offshore Cape Breton*" in May 2002. In this Statement the CNSOPB outlined four steps they intended to take to move the process forward to determine if exploration activities should proceed offshore Cape Breton. These steps include:

- continue the prohibition of activities on the licences until a determination is made as to whether exploration activities can proceed and, if so, on what terms and conditions;

- the Board will establish and invite appropriate groups to participate in the Fisheries Environmental Advisory Committee (FEAC) "ad hoc" working group;

- request the proponents to submit updated applications for work activity incorporating the knowledge gained from the public review process; and

- undertake expert review of the science, technical and experience utilizing the existing review mechanisms to determine if additional information is necessary to make informed decisions.

As a result of the recommendations of the Commissioner's report and the response of the CNSOPB an Ad Hoc Working Group has been established to provide advice to the Board

about whether the proposed activities should proceed, and the specific measures to be taken in the event the decision is to proceed with exploration. Participants include representatives from the three levels of government (Federal, Provincial, Municipal), First Nations, fishing organizations, environmental organizations, business community, trade unions, and licence holders.

A Science Review Working Group has also been established and a review of the science and experiential information pertaining to the proposed exploration activities has been completed. The report that follows is a report to the Ad Hoc Working Group on the details and findings of that review.

2.0 SCOPE OF SCIENCE REVIEW

The science review was focused on two proposed seismic surveys within exploration licences EL 2368, EL 2364 and EL 2365. Brief descriptions of the proposed activities are provided below.

2.1 OVERVIEW OF ACTIVITIES PROPOSED BY HUNT OIL

On August 6th, 2002 Hunt Oil submitted a revised proposal to conduct a 2D Seismic Survey within EL2364 and EL2365, in the Sydney Bight area, commencing in the fall of 2002. Due to the additional special review process of this application (Ad Hoc Working Group and Science Review Working Group), Hunt Oil's proposal has been delayed until the fall of 2003.

They propose to collect 1571 line kilometres of 2D seismic data. Acquisition time for the survey is estimated to be 20 days. The area covered by the survey is 104 x 81 km, and the water depth of this area ranges from 50 to 350 metres. The plan is to collect 25 lines of data, ranging from 21 to 128 km in length. Hunt Oil propose to space the lines between 3 to 6 km and use of a 2000-4000 cu. in. air gun array.

2.2 OVERVIEW OF ACTIVITIES PROPOSED BY CORRIDOR RESOURCES

On July 9, 2002, Corridor resources submitted a revised application to conduct a 2D Reflective Seismic Survey within EL2368, off the west coast if Cape Breton (see Figure 3 in Appendix A). An addendum to their application was submitted in September 2002 and an updated environmental assessment on October 28th, 2002.

They anticipate collecting 500 kilometres of seismic data, commencing in October or November 2003, requiring approximately one week of time to acquire. The water depth of the survey area ranges from 50 to 70 metres. Their proposal is to collect 26 lines of seismic data. The spacing of the lines is 1 to 2 km, and regional tie lines spaced at 12 km. Corridor Resources propose to use a 1000 cu. in. air gun array.

3.0 PURPOSE AND APPROACH

3.1 PURPOSE

The purpose of the science review as defined by the Commissioner was to *assess the existing base of scientific, technical and experiential knowledge in relation to the DFO review, the Hunt and Corridor proposals, and the Public Review Commission's Findings.*

Based upon the suggestions of the Commissioner, the Science Review was conducted by a working group composed of qualified people that together were able to provide a fairly complete overview of the science and experience at the base of any uncertainties.

Members of the Science Review Working Group agreed that their role was to assess scientific and experiential information and the gaps in this information to determine the likelihood of significant adverse environmental effects and provide advice to the Ad Hoc Working Group on these effects.

3.2 TIMELINES

Participants in the Science Review Working Group were finalized on September 6, 2002. The review process for the group was discussed in the first teleconference on September 11, 2002. The group convened September 30th – October 2nd, 2002 at the CNSOPB in Halifax to compile and discuss the issues and results of the identified concerns.

The Science Review Working Group recognized the timelines set by the Ad Hoc Working Group and the CNSOPB and attempted to work within them. As such, the aim was to provide the Ad Hoc group with the findings in the form of a Science Review Report prior to the November 6th meeting of the Ad Hoc Working Group. Following the September 30th –October 2nd, 2002 meeting and the submission of the revised Corridor environmental assessment it was determined that additional time would be needed to complete the review process. A second face to face meeting was held on November 25th and 26th, 2002 at the CNSOPB offices in Halifax. The Science Review report was completed in the days following this meeting and arrangements were made to present the report to the Ad Hoc Working Group on December 4th, 2002 in Cape Breton.

3.3 COMPOSITION OF THE SCIENCE REVIEW WORKING GROUP

Using the recommendations of the Commissioner's Report for guidance, the Science Review Working Group was established and consists of the following:

- Dr. Andrew Turnpenny – Nominated by CNSOPB
- Paul Keizer (Alternate – Paul Boudreau) – Nominated by DFO Maritimes
- Ross Alexander – Nominated by DFO Gulf

- Dr. John Chardine – Nominated by Environment Canada [Unable to continue his role in the review due to other commitments]
- Dr. Tony Lock – Nominated by Environment Canada [Replacement for John Chardine]
- Inka Milewski – Nominated by Environmental Organizations (Ad Hoc Working Group nomination) [Resignation received October 17th, 2002]
- Dr. Ron Loucks - Nominated by Environmental Organizations (Ad Hoc Working Group nomination) [Replacement for Inka Milewski]
- Dr. Trevor Kenchington – Nominated by the Union of Nova Scotia Indians (Ad Hoc Working Group nomination)
- Dr. Rolph Davis (Alternate – Denis Thomson) – Nominated by Corridor Resources (Ad Hoc Working Group nomination)
- Norval Collins – Nominated by Hunt Oil (Ad Hoc Working Group nomination)
- Erin Palmer – CNSOPB (Secretariat)
- Eric Theriault – CNSOPB (Chair).

In addition to the above participants, there was an option to invite persons with a scientific or technical expertise on a specific topic as guests to participate at a meeting. There was only one guest invited, an individual with direct experience dealing with underwater explosives.

3.4 General Process

The Science Review was conducted through teleconferences, ongoing email correspondence and face to face meetings. The first correspondence of the Science Review Working Group took place on September 11, 2002 via teleconference and was focused primarily on the review process.

Members of the Science Review Working Group agreed to follow the direction of the CNSOPB and focus the review on the Hunt EA, Corridor EA, DFO Habitat Status Report and the Commissioner's Report. These reports were mailed to each member after the initial teleconference. Members also agreed that additional or supplemental information thought to be of value to the review would also be considered. Documents of this nature were distributed between members via mail or email.

The first face to face meeting of the Science Review Working Group was hosted at the CNSOPB offices on September 30 to October 2, 2002. A facilitator, Dr. Scott MacKnight was contracted to assist in fleshing out the issues and reaching consensus on the findings. Throughout this meeting the guiding principles for the review process were discussed and a large portion of the science review was accomplished.

The Science Review Working Group started the review by focusing on first principles. Issues and concerns were identified based on pathways and the possibility of impact from the proposed seismic activities. The identified issues and concerns were grouped into

themes and presented to the participants the following day. For the most part, this process was successful and consensus was reached on several issues.

Concerns were raised regarding the completeness of the Corridor EA. DFO submitted a formal letter indicating that they would not provide comments on a draft document and chose not to review the assessment. Some members of the group also expressed a discomfort with reviewing the document. As a result of these concerns, it was decided that a review of the science and experiential information relating to the Corridor assessment should not be conducted until an updated assessment was available. Discussion at this meeting, therefore, was limited to the Hunt proposal. Members agreed that many of the issues being discussed were also applicable to the Corridor proposal, but indicated that they would need to be further discussed before being represented in the report.

On the second day of the meeting, the Science Review Working Group was joined by an individual with direct experience with underwater explosives. The expert entertained questions and provided comments relating to the sensitivity of munitions and the risks of underwater munitions related to oil and gas exploration activities.

Following the meeting, the issues and consensus items were distributed and on October 11th, 2002 a draft report (prepared by the secretariat) was circulated to the group. Members submitted comments on this draft to the chair of the working group by October 18th, 2002. Much discussion occurred via email on the structure and content of the report. The report was revised according to the comments received and the addition of brief descriptions explaining the consensus points for each issue were added.

An updated environmental assessment was submitted by Corridor Resources on October 28th, 2002 and a second face to face meeting of the Science Review Working Group was held on November 25th and 26th. The first day of the meeting focused on the remaining process issues and on issues relating to the Corridor application. Preliminary results of Phase 1 of the snow crab study were made available to the working group at this time. The second day focused on the remaining issues for the Corridor application, the revisiting of some issues for the Hunt application, and the drafting of the final report. By the end of the second day all members were comfortable that all relevant issues were covered and adequately represented in the report. Consensus was reached on all issues.

In the days following the meeting final changes and editorial comments were incorporated into the report. All members signed-off on the report and were willing to have it presented to the Ad Hoc Group.

3.5 Approach

The Science Review Working Group developed and adapted an approach to ensure an effective and consistent review process. The working group established and followed guiding principles, recognized and stated levels of scientific assertion, and assumed the

application of mitigation measures where appropriate. Each component of the approach and its application to the findings and conclusions of this report is outlined below.

3.5.1 Guiding Principles

The Science Review Working Group agreed upon several principles to guide the review process, including:

- The role of the Science Review Working Group would be to provide targeted advice to aid the Ad Hoc Working Group in their discussions.

- Decision-making would be based on consensus or agreement on each issue; and if consensus was not achieved, differences would be documented in the final report. The National Round Table of the Environment and the Economy (NRTEE) has summarized this approach in the statement below:

  "Although they (participants) may not agree on all aspects of the agreement, consensus is reached if all participants are willing to live with 'the total package'".

- Evaluation methods would be based on a reasonable certainty / precautionary approach.

  The Science Review Working Group recognized the many definitions and interpretations of reasonable certainty and the precautionary approach. The precautionary approach was believed most suitable for the purposes of the science review. The Department of Fisheries and Oceans, subscribing to the definition in the federal *Oceans Act,* defines the precautionary approach as:

  "in the face of scientific uncertainty, it is preferable to err on the side of caution"

  The working group also recognizes that the absence of full scientific certainty shall not be used as a reason to postpone decision-making.

- To ensure consistency with the Canadian Environmental Assessment Act (CEAA) mitigation measures and Environmental Effects Monitoring (EEM) would be discussed where appropriate. Under CEAA, no final determination can be made about the significance of the likely adverse environmental effects or the related matters unless the implementation of any appropriate mitigation measures has been considered.

- The Science Review Working Group would not re-examine information on the receiving environment or the quality of the environmental assessments, but rather focus on examining the effects of the proposed activities.

Attempts were made to conduct the scientific examination using the guiding principles listed above and this report is the result of this examination.

3.5.2 Expressing Levels of Certainty

Science can conclude either that there is no significant adverse effect or that there is such an effect. Accompanying each type of conclusion there is a fear or risk of drawing the wrong conclusion. If, for a specific issue, the Science Review Working Group concludes that there is no effect, there is the risk of failing to identify an actual adverse effect. If they find that there is a significant adverse effect, there is the risk of raising false concerns.

Four levels of scientific assertion can be recognized.

I. There is a complete series of precise and accurate observations, consistent with theory. The margins for error are narrow and enable the statement:
We are certain that ....

II. There is an incomplete series of observations (e.g., few observations from the particular ecosystem and species of interest), supplemented by a completed model / theoretical study. The margins for error are fairly narrow and enable the statement:
We are confident that ....

III. There is an incomplete series of observations supported by incomplete (e.g., calibrated but not validated) model / theoretical study. The margins for error are considerable. The statement can be:
We predict that ....

IV. There is an incomplete series of observations and either no model exists or the models are not validated or calibrated. The margins for error are substantial, but not as large as for pure chance. The statement can be:
It is our judgement that ....

The Science Review Working Group has used the above language in the issues and consensus statements that follow to signal the level of assertion that was made.

3.5.3 Mitigation Measures

In developing consensus statements, it was assumed by the Science Review Working Group that the operators would be willing to take, if necessary, the following mitigation measures:

- Seasonal optimisation to minimize potential effects on sensitive life stages and interference with fishing;
- 'Ramping up' procedures to incrementally increase power to the air gun array over 30 minutes thereby encouraging animals to leave the operating area prior to commencement of surveys;
- Retaining trained biological observers on board vessels;
- Deployment of guard boats to intercept other marine traffic;
- Shutting down seismic operations when whales are found to be within 1km of the seismic vessel;
- Consulting with fishermen and First Nations; and
- Providing financial compensation for damage to fishing gear.

In the statements of issues, concerns and consensus, the Science Review Working Group has referred to these mitigation measures where appropriate.

4.0 ISSUES, CONCERNS AND CONSENSUS

The Science Review Working Group has identified several issues with respect to the science in the Hunt EA, Corridor EA, DFO Habitat Status Report, and the Commissioner's Report. The surrounding concerns and items of consensus have been noted for each issue. The issues have been divided into two categories; *General or Overarching Issues*, and *Specific Issues* for each of the proposed activities. The issues are presented in an order to foster increased understanding of the review process; this order does not represent prioritization of the issues.

It is important to note that although many issues and topics were discussed by the Science Review Working Group not all of them were discussed at length or in detail and are therefore not represented in the issues and consensus statements. Some of these issues and the reasoning to support the limited discussion follow.

- Plankton – There is a considerable body of literature to support the position that the effects of seismic activity on plankton are negligible. Several members of the Science Review are familiar with this literature and the working group is confident that effects on plankton will be insignificant.
- Ecotourism and other human uses of the area (except fishing) – Ecotourism and other human uses of the seismic survey areas are minimal at the time of the proposed surveys (October and November), therefore the direct impact is expected

to be negligible. Indirect impacts, such as effects on whale watching have been addressed under specific issues, section 4.2.

- Introduction of exotic species – The possible risk of the introduction of exotic species from seismic survey vessels or gear is expected to be negligible. Species introductions occur most frequently from the exchange of ballast water; however, ballast water of seismic vessels is not regularly discharged. The vessels for the proposed activities will have been in the area for a considerable period of time before the survey, thereby further reducing the possibility of new species introductions.

Each issue identified below has been discussed at length and in detail by the Science Review Working Group. The details of these discussions are provided in four distinct sections: Concerns; Consensus; Explanation; and Advice. Concerns represent the concerns regarding the issue as expressed by the Science Review Working Group or by other stakeholders. Consensus statements outline the scientific or experiential evidence that has been agreed upon by the Science Review Working Group. Explanation is intended to explain the consensus points where it was felt that additional information was needed. Advice represents the advice given by the Science Review Working Group on that particular issue.

4.1 General or Overarching Issues

Issue - Scope of available information on marine resources in the study areas.

Concern

- Uncertainty in the available information may lead to a high uncertainty in the predicted impact.

Consensus

- Recognizing the uncertainty in the process, the working group has taken a conservative approach in its review.

Explanation

- Although there is uncertainty in the available information on marine resources for the study areas, in reaching consensus statements the working group believes it has erred on the side of caution. For example, by using cod as a model for all groundfish.

Issue - Characterization of the potential zone of influence

Concern

- Long-range propagation of the sound in the study area is not well understood and may lead to misinterpretation of the effects.

Consensus

- In the absence of detailed knowledge of the spread of sound in the study area the committee has taken a precautionary estimate of the range to which the effects may extend.
- For key issues it may be useful to model or measure the propagation of sound along critical paths prior to conducting a full survey.

Explanation

- Modelling and field measurements have been done on the Scotian Shelf and other areas around the world to assist in the prediction of the impacts of sound. In fairly homogeneous deep water areas it has been found that modelling provides a reasonable estimate of reality.
- Generally, modelling and measurements can only be applied to critical points, critical paths, or specific areas.
- Prior to conducting a full survey means that modelling and measurements should be conducted early enough for regulatory bodies to act or early enough for operators to make realistic adjustments to pre-defined scales.
- For modelling or measurements to be effective they may have to be conducted or taken at the same season as planned for the survey.
- Measurements taken at the time of survey should be a component of environmental effects monitoring (EEM).

Advice

- For key issues it may be useful to model or measure the propagation of sound along critical paths prior to conducting a full survey.

Issue - Extrapolation of information from one area to another.

Concern

- Extrapolation leads to false assumptions (e.g., propagation may differ, size or stage of an organism's life-cycle may lead to different responses).

Consensus

- Extrapolation is a normal part of the scientific process and appropriate provided due regard is given to differences in relevant factors.

Explanation

- Scientists can often assess relevant factors and extrapolate information from one area to another. For example, studies pertaining to the propagation of seismic sound might include a consideration of water temperatures and water depths as relevant factors. If these factors are considered it is reasonable for scientists to judge the results of studies against these factors and determine the extent to which the extrapolated results are applicable to the area or issue under investigation.

Advice

- Data from other areas should be used appropriately where available.

4.2 Specific Issues

Using the general issues as a baseline and the approach in section 3.5 the Science Review Working Group has identified and reached consensus on several specific issues.

4.2.1 Issues Relating to the Hunt Application

Issue - Information on responses of snow crab.

Concern

- Insufficient scientific evidence to assess the impacts.
- Presumption that ESRF study will answer the issue.
- Transferability of findings from Newfoundland to Cape Breton.
- An apparently small impact might have a long-term effect on the life cycle.

Consensus

- Adequate information exists on the distribution of the resource.
- Preliminary judgement indicates that there would be no perceptible negative impact on snow crab populations.
- ESRF study will provide useful information on physical and physiological effects and improve our understanding on behavioural effects and catch rate. There may still be outstanding uncertainties once the results of the study are known.
- Snow crab is likely the most exposed to sound of the benthic invertebrate resources and provides an adequate model for many benthic invertebrates.

Explanation

- Our judgement is based upon the physiology of crustaceans, the relative lack of effect of explosives on crustaceans, the absence of air containing organs, and the lack of sensitivity to sound pressure (likely to react only in near field).
- Preliminary results of the ESRF study are consistent with our judgement.
- Both areas contain a full spectrum of the populations (males, females, juveniles) and support a valued fishery.

Advice

- We recommend that Ad Hoc Working Group advise the CNSOPB to wait for the results of this study before making a decision on the significance of impacts of the proposed activities on snow crab.

Issue - Information on responses of fish.

Concern

- Seismic exploration in Sydney Bight could have a long-term effect on the fragile cod population.
- Use of cod and herring as reasonable representatives for all fish species.
- Transferability of Norwegian (Barents Sea) data.
- Duration of behavioural effects uncertain.
- Hearing damage and other sub-lethal effects may occur.

Consensus

- Herring and cod are expected to provide adequate models for the fish species present in the study area (cod for the groundfish; herring for pelagics).
- Behaviour of 4Vn cod is likely to be influenced by seismic sound, with the results that an unknown proportion of the population might move away from the normal overwintering grounds.
- 4T cod may be less affected. On the overwintering grounds there should be less effect due to a more dispersed population and availability of alternative habitat. During migration the effect may be to alter migration patterns.
- Norwegian data allow an estimate of the likely maximum response distance for cod.
- There is a need to examine the size of the fish in the study area relative to the Norwegian study, which showed that cod >60 cm in length moved the greatest distances; smaller fish would be expected to undergo smaller displacements.
- Some herring are likely to be influenced by seismic noise, with the possible result of moving outside normal overwintering grounds.
- Herring spawning in nearshore areas occurs in Sydney Bight from mid August to mid October, occasionally extending into early December. There is potential for the last of the spawning adults to be disturbed by seismic sound. The attenuation of the sound entering these nearshore areas may be sufficient to mitigate these potential effects.
- Indications are that displacement is short term.
- Fish exhibit some degree of avoidance which would reduce the risk of hearing damage or other sub-lethal effects

Explanation

- Several species of finfish are present in the Sydney Bight area in the fall. Among these, the effects of seismic surveys on cod are of particular concern and this is one species for which there is some scientific information on its responses to seismic sound. Cod can serve as an adequate model for all of the other groundfish species in the area, the rest of which should be affected no more, and in some cases much less, than cod because of their distributions or their poorer hearing ability. Cod cannot, however, serve as a useful model for pelagic fish. Herring was, therefore, selected for that purpose, although little information is available about the effects of

airguns on herring. The other major pelagic species in the area, mackerel and tuna, should be much less affected than herring because they lack the special hearing abilities of the herring family and because they do not have air-filled swimbladders. In our judgement, cod and herring represent conservative models of the effects of seismic surveys on other groundfish and pelagics respectively.

- Two distinct stocks of cod are present in the area. Adults of the Sydney Bight resident stock (4Vn cod) move into the Laurentian Channel in the fall (with the greatest movement in early November) and then overwinter in the Channel amongst the far more numerous, migratory Southern Gulf (4T) cod -- though the precise overwintering grounds of the resident fish are not well known. Juvenile 4Vn cod live in shallower water than the adults and may remain in the area of the proposed seismic survey through the fall and winter. The 4Vn stock is considered to be in a fragile state, following severe declines in abundance in previous decades. The 4T cod spend the summer in the southern Gulf of St. Lawrence, moving into the Laurentian Channel and around Cape North from October onwards. Through November, there is a large concentration of them near St. Paul's Island but not as many further to the southeast. The concentration near St. Paul's Island remains all winter but by January the fish are more widespread in the Laurentian Channel, with a second concentration on the slope off Smokey Bank. The 4T stock is not as severely depleted as the 4Vn one but it is not recovering despite many years of restricted fishing. The state of this stock is, therefore, also of great concern.
- The effects of the proposed seismic survey on these fish can be inferred from the results of Norwegian experiments, particularly one in which cod were observed to move 35km away from a seismic vessel operating in the Barents Sea. Because of the different environmental conditions in Sydney Bight, the distance across which fish might move in response to seismic sound is expected to be less than it was off Norway but 35km can be used as a conservative approximation -- meaning that actual effects should be smaller than those estimated.
- Much of the fall and winter range of the 4Vn cod lies within 35km of the proposed seismic lines and so we judge that some proportion of the fish may be displaced away from their normal overwintering grounds. What the consequences might be is unknown but there is the potential for faster use of energy reserves, leading to lower over-winter survival, and for other similar losses of "fitness".
- Juvenile 4Vn cod are unlikely to be displaced as far as the adults by seismic sound. (Larger fish are known to be moved further and faster than small ones.) Some of them may be in the survey area, directly under the airguns, during the proposed shooting. There is some risk that those fish might suffer sub-lethal physical damage, such as a loss of hearing ability. That risk is, however, judged to be small.
- The 4T cod have extensive overwintering grounds, extending from St. Paul's Island southeast along the Laurentian Channel to the slopes of Banquereau. The proposed seismic survey might move some individuals within this large area but would probably not drive any outside it. Thus, we judge there to be an even lower risk of impacts on the population than with 4Vn cod. It is also possible that the seismic survey could alter the migration of these cod out of the Gulf, perhaps by halting some of them near St. Paul's Island, outside 35km from the nearest seismic line, for

the duration of the survey. Should that happen, there might be no lasting consequences for the stock since many cod appear to remain naturally in that area until late in the year.

- The overwintering grounds of herring include the Laurentian Channel off Sydney Bight and some individuals might be displaced within their overwintering grounds by seismic sound, as could happen with cod. The extent of those movements cannot be predicted for lack of knowledge of the responses of herring-like fish to seismic surveys. Minor population-level impacts are not impossible, as with cod, though they are not likely and the herring stocks are not in the same fragile state as cod -- hence unlikely minor impacts may not be of much concern.
- The fall-spawning herring in Sydney Bight mostly finish spawning by mid-October. Some individuals in some years can, however, be found spawning as late as early December. Their spawning beds are in very shallow, nearshore waters, some of which lie within 20km of the nearest proposed seismic line. Sound entering such areas from offshore is, however, attenuated as it moves over the seabed and so the intensity that would actually reach the spawning herring would be very much reduced, perhaps so much so that the fish would not respond at all. If herring spawning behaviour were altered, only the last few fish on the spawning beds would be affected. There is some chance that those few represent a different sub-population to the ones spawning earlier and so their disruption might not be a trivial issue but it would certainly not be comparable to disturbance of the peak spawning time.
- The proposed seismic survey would cover a considerable area over a reasonable period of time. While it was in progress, the various stocks of fish would be moving through the area. Judicious scheduling of the inshore and offshore seismic lines could serve to keep the airgun shooting away from the most important concentrations of fish, thus reducing the risk of impacts.

Advice

- No window of opportunity exists between October and December that will eliminate the risks to finfish. Delaying the surveys into November would increase the risk to 4T cod. In inshore areas the risks to 4Vn cod would decrease into November. The timing of inner and outer seismic lines will affect the risk to these resources. The risk is that the seismic survey will disrupt the migration and may affect overwintering stocks. Whether or not this is an acceptable risk calls for a value judgement, taking into account the status of these stocks.
- Altering the sequence of seismic lines can be an effective mitigation measure. If the project is to proceed, CNSOPB and the operator, in consultation with DFO, should consider ways to schedule various seismic lines to minimize risk to cod.
- If the project is to proceed, the lowest power of array possible should be used.

Issue - Scientific fish surveys

Concern

- Interference of seismic survey with long-term scientific fish surveys.

Consensus

- There is a procedural mechanism in place to ensure that seismic surveys do not interfere with fish surveys.

Explanation

- There is a possibility for seismic surveys to occur in areas where and at times when long-term scientific fish surveys are taking place. Such overlaps could interfere with the survey results. CNSOPB undertakes standard consultation with DFO and the FEAC and to date modifications to programs have been made to avoid any conflicts. DFO surveys are generally complete by the end of October.

Advice

- With this mechanism in place we are confident that fish surveys will not be significantly affected.

Issue - Seismic survey effects on fisheries

Concern

- Potential for seismic to interfere with catch per unit effort (CPUE).
- Physical limits placed on fishing by seismic vessel.

Consensus

- There may be a local redistribution of stock in the vicinity of the survey. This could affect CPUE of those fisheries operating during the time of the survey.
- Standard procedures exist for consultation between seismic companies and fishing vessels. Efforts are made to minimize any physical interaction. There is a standard compensation program for damaged gear.

Explanation

- We are confident that there will be some local redistribution of finfish, but it is our judgement that crabs are less likely to move.

Advice

- No additional action is required.

Issue - Information on responses of sea turtles.

Concern

- Less knowledge for turtles than for fin-fish or marine mammals.
- Leatherback turtle is listed as endangered under COSEWIC.
- It is not clear that the behavioural response would protect the turtles from injury.
- If turtles do leave the area prematurely it is not known what impact this would have.

Consensus

- Based on our knowledge of sound and turtle response we predict that any effects are likely to be sublethal, affecting fitness of exposed individuals only.
- EA mitigation measures (as listed in section 3.5.3) could reduce, and conducting the survey after turtles have left the study area would eliminate, risks.

Explanation

- Turtles have relatively good hearing and we are confident that turtles will show an avoidance response to sound which, in our judgement, will provide some protection from the potential impacts of seismic activities. Turtle swimming speeds are relatively low and hence a slower ramp up for seismic sound is appropriate. Few individuals are expected to be in the vicinity of seismic activities at any one time and with mitigation measures in place we are confident that the potential effects on turtle populations will not be significant.

Advice

- We recommend that the ramp up be a minimum of 30 minutes to allow for the turtle swimming speed.

Issue - Information on responses of sea associated birds.

Concern

- Physiological effects unknown.
- Murres and Dovekies could be impacted.
- Possible lethal effects to diving birds.

Consensus

- Based on reports from observers on seismic vessels lethal effects are expected to be minimal.
- We are confident that any effects are expected to be at the individual level, rather than the population level.
- Mitigation measures proposed for other animal groups may benefit seabirds.

Explanation

- Murres and Dovekies are deep diving species and are more likely to be affected by seismic exploration sound than non-diving species, such as gulls. These species are part of the winter avifauna that is moving into the area at the time of these surveys. Observers onboard seismic vessels, however, seldom note birds affected by the seismic program.

Advice

- No further mitigation is required, however, please refer to section 5.2.2 regarding observations.

Issue - Information on responses of marine mammals.

Concern

- Whale migration might be affected.
- Feeding of seals might be affected.
- Blue and Right whales are listed as endangered under COSEWIC.
- Detection of marine mammals at times of low visibility.
- Potential for hearing loss.

Consensus

- With the proposed mitigation measures we predict that behavioural avoidance would protect marine mammals from hearing loss.
- We predict that there will be displacement of any remaining whale migration to avoid seismic sound but the displacement is not expected to be critical.
- Seals are less sensitive to sound than whales.
- It is predicted that very little redistribution of feeding effort for seals will occur.

Explanation

- Mitigation measures, such as ramping up, are likely to cause a behavioural avoidance response in marine mammals whereby they would leave the area of seismic activity prior to the occurrence of hearing damage. Whales are likely to disperse from the area and may be displaced from their typical migration routes. This displacement is likely to be relatively small in scale and it is unlikely that it would affect overall migration patterns.

Advice

- Mitigation measures in section 3.5.3 should be applied.

Issue - Uncertainty of location of munitions, including chemical warfare agents and UXOs.

Concern

- Seismic exploration will disturb or damage munitions
- Potential ecotoxicity of chemical warfare agents if dispersed by seismic airgun emissions

Consensus

- There is a very low likelihood of seismic exploration affecting old munitions, due to low energies reaching the sea bed at the water depths involved.
- There may be a greater risk to the environment and human safety through bottom interactions with ordnance via routes other than seismic exploration
- For exploration drilling a hazards site survey is routine protocol.

Explanation

- Disturbance of munitions in most cases would require a direct impact and much higher energy levels than would reach the sea floor from seismic surveys. A direct

impact to munitions sites could possibly occur from the placement of drilling equipment, however, site surveys which involve detailed mapping of the sea floor are required for each drilling project. Remote sensing technologies are available for detecting UXOs and chemical weapons.

Advice
- No additional action is required.

Issue - Cumulative and Ecosystem Effects

Concern
- Adjacent seismic surveys running concurrently.
- The proposed activity may add additional stress to already stressed populations and organisms.
- Fishing mortality and other human induced mortality on marine organisms.
- Shipping activity (commercial, fishery, military).
- Seismic programs may lead to further exploration and consequently to production.

Consensus
- Regulatory agencies could coordinate activities to take concurrent surveys into consideration.
- There is evidence of long term ecosystem impacts. The degree to which the proposed activities would add to this effect is currently unknown.
- At the time of the proposed survey there are few other conflicting activities occurring in the area, but many other stresses are continuous.
- At the application stage for seismic exploration it is not practical to assess the effects of further exploration and production. The subsequent activities will be subject to site-specific CEAA environmental assessments.

Explanation
- It is difficult to separate the long-term population level effects of large amounts of seismic survey activities conducted from the effects of the many other human induced and natural stressors on the environment.
- Exploration and production activities would be very site specific and the nature of the activities cannot be predicted because we do not know the level of technology that will be available for future projects. The type of hydrocarbons that would be produced is also unknown. Therefore, it is difficult to design a scenario for assessment.

Advice
- Regulatory agencies should coordinate activities to take concurrent surveys into consideration.

4.2.2 Issues Relating to the Corridor Application

Issue - Information on responses of snow crab.

Concern

- Insufficient scientific evidence to assess the impacts.
- Presumption that ESRF study will answer the issue.
- Transferability of findings from Newfoundland to Cape Breton.
- An apparently small impact might have a long-term effect on the life cycle.

Consensus

- Adequate information exists on the distribution of the resource.
- Preliminary judgement indicates that there would be no perceptible negative impact on snow crab populations.
- ESRF study will provide useful information on physical and physiological effects and improve our understanding on behavioural effects and catch rate. There may still be outstanding uncertainties once the results of the study are known.
- Snow crab is likely the most exposed to sound of the benthic invertebrate resources and provides an adequate model for many benthic invertebrates.

Explanation

- Our judgement is based upon the physiology of crustaceans, the relative lack of effect of explosives on crustaceans, the absence of air containing organs, and the lack of sensitivity to sound pressure (likely to react only in near field).
- Preliminary results of the ESRF study are consistent with our judgement.
- Both areas contain a full spectrum of the populations (males, females, juveniles) and support a valued fishery.

Advice

- We recommend that Ad Hoc Working Group advise the CNSOPB to wait for the results of this study before making a decision on the significance of impacts of the proposed activities on snow crab.

Issue - Information on responses of fish.

Concern

- Effects on highly valued Margaree River salmon stock.
- Primarily salmon, overwintering flatfish and forage species, and migratory fish.
- Use of cod as reasonable representatives for all groundfish.
- Transferability of Norwegian (Barents Sea) data.
- Duration of behavioural effects uncertain.
- Hearing damage and other sub-lethal effects may occur.

Consensus

- Salmon are less sensitive to sound than flatfish, which are less sensitive to sound than cod. Relative behavioural reaction thresholds to seismic sound are unknown.
- Most spawning salmon should be in fresh water by the first of November; fish entering their first sea winter may be in the seismic survey area.
- Due to the likely low reaction and the timing of the movement into fresh water impacts to spawning salmon should be small.
- Cod are expected to provide an adequate model for the responses of groundfish species present in the study area.
- DFO advises that cod are passing through the area in late October and early November. Based on scientific studies we know that cod will be affected; the degree of this effect is unknown. There is a risk that migration paths and overwintering habitats could be altered. The impacts of these changes are unknown.
- Norwegian data allow an estimate of the likely maximum response distance for cod. The smaller airgun array proposed would reduce the distance by about 40%.
- There is a need to examine the size of the fish in the study area relative to the Norwegian study, which showed that cod >60 cm in length moved the greatest distances; smaller fish would be expected to undergo smaller displacements.
- White hake migrate in November and December, otherwise, impacts are similar to those for cod. Smaller fish tend to migrate later. The stock is in a precarious state.
- Overwintering flatfish and forage fish will also be affected.
- Indications are that displacement is short term.
- Fish exhibit some degree of avoidance which would reduce the risk of hearing damage or other sub-lethal effects

Explanation

- Salmon are about ten times less able to hear low-frequency sound than are cod. They also show a very strong migratory drive. These aspects of salmon biology suggest that they would tend to ignore seismic-survey sounds that would cause cod to move away. The airgun array proposed for use would be substantially smaller than the one employed in the Norwegian (Barents Sea) experiment, while the survey lines would not be closer than 25 km from the mouth of the Margaree River. Thus, even salmon in the river mouth should not be affected by the seismic shooting. Salmon running into the river should not be affected at all -- though that cannot be guaranteed. There would be more potential for impacts on spawning-run salmon that were in the sea, north of the river mouth, when a survey started. That potential could be almost eliminated by delaying the survey until 1st November, by which time most of the spawning salmon have entered freshwater.
- Young salmon spending their first winter at sea disperse away from the river mouth but it is not known how far they go. Some of them (perhaps a small fraction or perhaps a large one) could be in the area of the seismic survey. Such fish would likely respond in a similar manner as cod, though perhaps to a lesser extent. The consequences of that disturbance for their survival and growth are unknown.
- Much of the Southern Gulf cod stock migrates through the area of the proposed survey in late October and early November. The fish are expected to respond, perhaps by altering their migration path ten kilometres or more to the westward but

perhaps in other ways. The larger individuals are likely to move further in response to the sound. Whether the resulting changes in migration paths would have any more lasting effect is unknown. In fall, the cod are in good condition, having finished a season of feeding. However, they use their food reserves to survive the winter and there is some reason to think that the slow recovery of this stock may be linked to a lack of reserves in late winter. If so, disturbance of the fish during their fall migration might have population consequences by causing them to use energy inefficiently. This stock is currently seriously depleted and showing little sign of recovery. Even a low risk of further depression might be deemed unacceptable.

- Most of the Southern Gulf white hake stock migrates through the proposed survey area in November and December, heading north from St. Georges Bay and the eastern end of the Northumberland Strait. Hake would probably respond to the sound in much the same way as cod, except that the survey area lies more directly astride the migration route for these fish. As with cod, it is not known whether there would be any lasting effects on the population but, again like cod, the hake stock is depressed. It has been described as being in a "precarious state". Delaying the seismic survey until mid-November to reduce impacts on cod would only increase any effects on hake.
- The other commercial groundfish species in the area include plaice, witch and winter flounders. Witch flounder leave in October, adult plaice in November and December while at least some winter flounder move into estuaries where they would be sheltered from seismic sound. Juvenile plaice may remain in the proposed survey area all winter. Flatfish have relatively poor hearing and would not be expected to move away from the shooting as much as cod might. Their presence relatively close to the airguns could increase their risk of hearing damage or other sub-lethal effects, though that risk is thought to be low.
- Mackerel, herring and the other migratory pelagic species generally leave the Gulf by September or October. The fall herring spawning ends about mid-October which is around the proposed start time of the seismic survey. Thus, these species should be little affected. Some less migratory species may remain in the proposed survey area and could be impacted in a similar way to the flounders. Those include gaspareau (which has the acute hearing capability of the herring family), smelt and tomcod. While of only secondary economic importance themselves, those species are important to the ecosystem supporting many other animals.

Advice

- No window of opportunity exists between October and December that will eliminate the risks to finfish. Delaying the surveys into November would reduce the risk to salmon and cod but increase the risk to hake. The risk is that the seismic survey will disrupt the migration to the extent that it has population level effects on salmon, cod or hake. Due to the short duration of the survey and the low power of the airguns this risk is judged to be very low. Whether or not this is an acceptable risk calls for a value judgement, taking into account the status of these stocks.

Issue - Scientific fish surveys

Concern

- Interference of seismic survey with long-term scientific fish surveys.

Consensus

- There is a procedural mechanism in place to ensure that seismic surveys do not interfere with fish surveys.

Explanation

- There is a possibility for seismic surveys to occur in areas where and at times when long-term scientific fish surveys are taking place. Such overlaps could interfere with the survey results. CNSOPB undertakes standard consultation with DFO and the FEAC and to date modifications to programs have been made to avoid any conflicts. DFO surveys are generally complete by the end of September.

Advice

- With this mechanism in place we are confident that fish surveys will not be significantly affected.

Issue - Seismic survey effects on fisheries

Concern

- Potential for seismic to interfere with catch per unit effort (CPUE).
- Physical limits placed on fishing by seismic vessels.

Consensus

- Little fishing activity is expected within the seismic survey area at this time of year.
- There may be a local redistribution of stock in the vicinity of the survey. This could affect CPUE of those fisheries operating during the time of the survey.
- Standard procedures exist for consultation between seismic companies and fishing vessels. Efforts are made to minimize any physical interaction. There is a standard compensation program for damaged gear.

Explanation

- We are confident that there will be some local redistribution of finfish, but it is our judgement that crabs are less likely to move.

Advice

- No additional action is required.

Issue - Information on responses of sea turtles.

Concern

- Less knowledge for turtles than for fin-fish or marine mammals.
- Leatherback turtle is listed as endangered under COSEWIC.
- It is not clear that the behavioural response would protect the turtles from injury.
- If turtles do leave the area prematurely it is not known what impact this would have.

Consensus

- Based on our knowledge of sound and turtle response we predict that any effects are likely to be sublethal, affecting fitness of exposed individuals only.
- EA mitigation measures (as listed in section 3.5.3) could reduce, and conducting the survey after turtles have left the study area would eliminate, risks.

Explanation

- Turtles have relatively good hearing and we are confident that turtles will show an avoidance response to sound which, in our judgement, will provide some protection from the potential impacts of seismic activities. Turtle swimming speeds are relatively low and hence a slower ramp up for seismic sound is appropriate. Few individuals are expected to be in the vicinity of seismic activities at any one time and with mitigation measures in place we are confident that the potential effects on turtle populations will not be significant.

Advice

- We recommend that the ramp up be a minimum of 30 minutes to allow for the turtle swimming speed.

Issue - Information on responses of sea associated birds.

Concern

- Physiological effects unknown.
- Murres and Dovekies could be impacted.
- Possible lethal effects to diving birds.

Consensus

- Based on reports from observers on seismic vessels lethal effects are expected to be minimal.
- We are confident that any effects are expected to be at the individual level, rather than the population level.
- Mitigation measures proposed for other animal groups may benefit seabirds.

Explanation

- Murres and Dovekies are deep diving species and are more likely to be affected by seismic exploration sound than non-diving species, such as gulls. These species are part of the winter avifauna that is moving into the area at the time of these surveys. Observers onboard seismic vessels, however, seldom note birds affected by the seismic program.

Advice

- No further mitigation is required, however, please refer to section 5.2.2 regarding observations.

Issue - Information on responses of marine mammals.

Concern

- Whale migration might be affected.
- Feeding of seals might be affected.
- Blue and Right whales are listed as endangered under COSEWIC.
- Detection of marine mammals at times of low visibility.
- Potential for hearing loss.

Consensus

- Most large whales are no longer in the area by late October. Pilot whales may be in the area at this time.
- With the proposed mitigation measures we predict that behavioural avoidance would protect marine mammals from hearing loss.
- We predict that there will be displacement of any remaining whale migration to avoid seismic sound but the displacement is not expected to be critical.
- Seals are less sensitive to sound than whales.
- It is predicted that very little redistribution of feeding effort for seals will occur.

Explanation

- Mitigation measures, such as ramping up, are likely to cause a behavioural avoidance response in marine mammals whereby they would leave the area of seismic activity prior to the occurrence of hearing damage. Whales are likely to disperse from the area and may be displaced from their typical migration routes. This displacement is likely to be relatively small in scale and it is unlikely that it would affect overall migration patterns.

Advice

- Mitigation measures in section 3.5.3 should be applied.

Issue - Uncertainty of location of munitions, including chemical warfare agents and UXOs.

Concern

- Munitions, chemical warfare agents and UXOs might be present in the area.
- If present, seismic exploration will disturb or damage munitions and disperse contents.

Consensus

- There is no known evidence of munitions dump sites in the seismic survey area.
- There is a very low likelihood of seismic exploration affecting old munitions, due to low energies reaching the sea bed at the water depths involved.
- There may be a greater risk to the environment and human safety through bottom interactions with ordnance via routes other than seismic exploration
- For exploration drilling a hazards site survey is routine protocol.

Explanation

- Disturbance of munitions in most cases would require a direct impact and much higher energy levels than would reach the sea floor from seismic surveys. A direct impact to munitions sites could possibly occur from the placement of drilling equipment, however, site surveys which involve detailed mapping of the sea floor are required for each drilling project. Remote sensing technologies are available for detecting UXOs and chemical weapons.

Advice

- No additional action is required.

Issue - Cumulative and Ecosystem Effects

Concern

- Adjacent seismic surveys running concurrently.
- The proposed activity may add additional stress to already stressed populations and organisms.
- Fishing mortality and other human induced mortality on marine organisms.
- Shipping activity (commercial, fishery, military).
- Seismic programs may lead to further exploration and consequently to production.

Consensus

- Regulatory agencies could coordinate activities to take concurrent surveys into consideration.
- There is evidence of long term ecosystem impacts. The degree to which the proposed activities would add to this effect is currently unknown.

- At the time of the proposed survey there are few other conflicting activities occurring in the area, but many other stresses are continuous.
- At the application stage for seismic exploration it is not practical to assess the effects of further exploration and production. The subsequent activities will be subject to site-specific CEAA environmental assessments.

Explanation

- It is difficult to separate the long-term population level effects of large amounts of seismic survey activities conducted from the effects of the many other human induced and natural stressors on the environment.
- Exploration and production activities would be very site specific and the nature of the activities cannot be predicted because we do not know the level of technology that will be available for future projects. The type of hydrocarbons that would be produced is also unknown. Therefore, it is difficult to design a scenario for assessment.

Advice

- Regulatory agencies should coordinate activities to take concurrent surveys into consideration.

5.0 Conclusions and Recommendations

5.1 Conclusions

Three general issues and nine specific issues on each proposed activity were identified and discussed through the course of this review. The Science Review Working Group considers each issue relevant and important, but not necessarily equal. The concerns, consensus and final advice items should all be considered by the Ad Hoc Working Group. However, we conclude that the most critical issues are uncertainties regarding impacts to snow crab, risks to finfish, and ecosystem effects, such as the additional effect of seismic on the existing natural and human induced factors impacting cod populations.

The resources and environment in both Sydney Bight and the Southern Gulf of St. Lawrence are known to be experiencing some level of stress. Generally, the effects of seismic activities are considered to be small, however, given the context of the environment, the risk of a problem that may otherwise be considered insignificant may now become a concern. Concerns over the effects of the proposed seismic activities are heightened because of the concentration of stocks in the survey areas, the fragility of some of the stocks, the location of the migration routes and overwintering grounds, and the commercial and conservation values of the stocks.

In the case that the proposed activities are to proceed, it will be necessary that the mitigation measures listed within this document are implemented and that minimal levels of sound output are used to obtain the required geological data. The implementation of these measures should reduce population level effects on marine mammals and turtles

(including species at risk) to negligible levels. These measures will also reduce, but not eliminate, the risks to other resources and the receiving environment.

The Science Review Working Group has agreed that there exists a considerable body of knowledge relating to many of the biological, physiological, oceanographic, and other factors that are critical in gaining an adequate understanding of our resources and the potential effects of seismic activities on these resources. In many cases, although knowledge of resources and the surrounding environment exists, it is often skewed towards areas of intense study and is not necessarily representative of the true environment. Knowledge and studies predicting the effects of seismic on these resources and environment is generally weak. When combining the knowledge of our resources with our knowledge of the effects of seismic we end up with patchy scientific evidence. Although in many cases reasonable decisions can be made from this information, there is benefit to increasing confidence in decision-making through bridging the identified gaps.

Further research and well defined Environmental Effects Monitoring (EEM) studies can assist in increasing knowledge where gaps are known to exist.

5.2 Recommendations

5.2.1 Environmental Effects Monitoring (EEM)

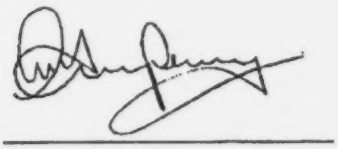
EEM is not normally required for seismic programs, however, given the inshore nature of these projects and the apparent lack of effective or serious EEM relating to seismic, EEM should be required if the projects are allowed to proceed. EEM should incorporate some measure of received sound levels. These programs should be developed cooperatively, involving the proponent, CNSOPB, DFO, EC, and the community.

5.2.2 Incidental Observations

Incidental observation can provide useful information on species presence or absence and possibly even general effects of seismic on certain species. It is important that incidental observations are made whenever possible. In general, we encourage operators to consult with CNSOPB, CWS, and DFO to design appropriate observation programs for marine birds and mammals.

6.0 DOCUMENT ACCEPTANCE

All members of the Science Review Working Group have reached a consensus on the contents and conclusions of this report and agree with the information within. This document was finalized on November 29th, 2002 with the agreement of all working group members.



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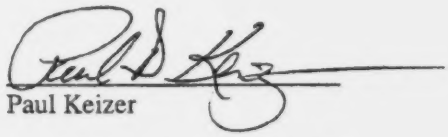

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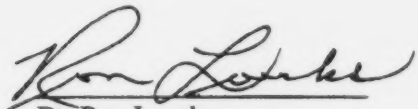

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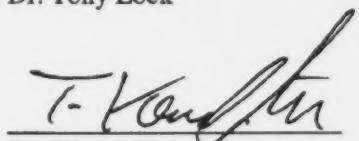

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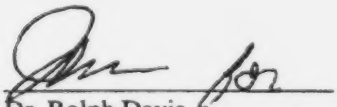

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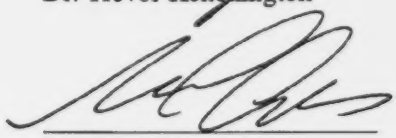

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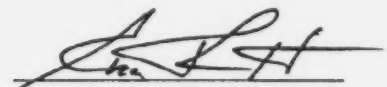

Eric Theriault (Chair)

Erin Palmer (Secretariat)